National Aeronautics and Space Administration

NAC HEO Committee Report
July 28, 2016

N. Wayne Hale | Interim Chair | NAC HEO Committee

In Memorium

- **Their Lives Enriched Us, They served our Country:**

NAC HEO Committee Members

- **Mr. N. Wayne Hale*** (Interim Chair)
- **Ms. Nancy Ann Budden** (Vice Chair)
- **Dr. Leroy Chiao**
- **Dr. Pat Condon**
- **Mr. Tommy Holloway**
- **Mr. Lon Levin**
- **Dr. David Longnecker**
- **Mr. Michael Lopez-Alegria**
- **Ms. Ruth Gardner*** (telecon)
- **Mr. Gerald Smith***
- **Dr. Pat Sanders** (ASAP Interim Chair)
- Mr. Joe Cuzzupoli
- Mr. Bob Sieck
- Ms. Shannon Bartell
- Mr. Jim Voss
- **Mr. Jim Odom** (resigned)
- **Mr. Dick Malow** (deceased)

Agenda from July 25 – 26, 2016

- **Status of HEOMD**
  Mr. Bill Gerstenmaier
- **Status of Exploration Systems Development**
  Mr. Bill Hill
- **Status of International Space Station**
  Mr. Sam Scimemi
- **Research Subcommittee Update**
  Dr. David Longnecker
- **International Space Station Research**
  Mr. Angel Otero
- **Status of Asteroid Redirect Mission**
  Mr. Ron Ticker
- **System Maturation Teams ECLSS/ Fire Safety**
  Ms. Robyn Gatens
- **Habitation Module Talk**
  Mr. Jason Crusan
- **Status of Commercial Crew Program**
  Mr. Phil McAlister

Increment 48 Overview: Crew

46S Dock 3/19/16
46S Undock 9/7/16

Oleg Skripochka
FE (R) – 46S

Jeff Williams
CDR (US) – 46S

Alexey Ovchinin
FE (R) – 46S

47S Dock 6/26/16
47S Undock 10/30/16

Anatoli Ivanishin
FE (R) – 47S
(CDR Inc. 49)

Kate Rubins
FE (US) – 47S

Takuya Onishi
FE (J) – 47S

For current baseline refer to SSP 54100 Multi-Increment Planning Document (MIPD)

ISS Flight Plan

Flight Planning Integration Panel (FPIP)

(Pre-decisional, For Internal Use, For Reference Only)

NASA: OC4/John Coggeshall
MAPI: OP/Randy Morgan

Chart Updated: July 07th, 2016

2016 | 2017

Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug

Inc 48 | Inc 49 | Inc 50 | Inc 51 | Inc 52

Crew Rotation

- J. Williams (CDR-48) 172 days (46S)
- A. Ovchinin 172 days (46S)
- O. Skripochka 172 days (46S)
- S. Kimbrough (CDR-50) 155 days (48S)
- A. Borisenko 155 days (48S)
- S. Ryzhikov 155 days (48S)
- A. Misurkin (CDR-52) 170 days (50S)
- N. Tikhonov 170 days (50S)
- M. Vande Hei 170 days (50S)
- A. Ivanishin (CDR-49) 115 days (47S)
- T. Onishi 115 days (47S)
- K. Rubins 115 days (47S)
- P. Whitson (CDR-51) 181 days (49S)
- T. Pesquet 181 days (49S)
- O. Novitsky 181 days (49S)
- F. Yurchikhin (CDR-53) 151 days (51S)
- J. Fischer 151 days (51S)
- P. Nespoli 151 days (51S)
- (SpX-DM2)
- (SpX-DM2)

Soyuz Lit

07/14 | 08/07 | 09/09 | 10/12 | 11/02 | 12/15 | 12/31 | 02/10 | 03/03 | 04/06 | 05/09 | 06/02 | 07/11 | 08/04

Landing

07/17 | 09/10 | 11/05 | 01/03 | 03/09 | 05/15 | 07/14

Stage S/W

X2 PMPV R5 7/22

(Transition required prior to first crewed VV)

X2 R15 2/13

Stage EVAs

(IDA2 Install) | (TTCR) | (Battery R&R A-B) | (Contingency C) | (Contingency D-F) | (ExPCA) | (NODE 3) | R-43

Port Utilization

MRM2 / SM Zenith

9/6 | 9/25 (34 orbit rendezvous) | 2/25 | 3/11 | 8/28

172 / 172 | Landing 9/7 early GMT | 155 / 153 | 170 / 170

46S | 48S | 50S

MRM1 / FGB Nadir

7/9 (34 orbit rendezvous) | 10/30 | 11/16 (Early GMT) | 5/15 | 5/29

115 / 113 | 181 / 181 | 151 / 151

47S | 49S | 51S

DC1

7/3 | 7/19 (34 orbit rendezvous) (Early GMT) | 1/19 | 2/1 | 6/13 | 6/15

186 / 184 | 132 / 132 | 185 / 185

62P | 64P | 66P | 67P

SM Aft

10/14 | 10/20 | 4/29

197 / 195 | 191 / 191

63P | 65P

N2 Fwd / PMA2 Dock

IDA #2 installed on PMA2

5/12 | 6/7 | 26 Days | SpX-Demo1 (un-crewed)

8/24 | 22 D | SpX-Demo2 (crewed)

N2 Zenith Dock

N2 Nadir Berth

7/20 | 8/29 | 40 Days | SpX-9

10/4 | 11/11 | 38 Days | HTV6

11/13 | 12/20 | 37 Days | SpX-10

HTV6 KITE experiment

2/3 | 3/5 | 30 Days | SpX-11

6/3 | 7/3 | 30 Days | SpX-12

N1 Nadir Berth

9/1 | 9/10 | 9 D | OA-5

1/2 | 4/2 | 90 Days | OA-7

7/9 | 8/25 | 47 Days | OA-8

Solar Beta >60

07/22 -07/31 | 10/24 -10/30 | 12/20 -12/30 | 02/21 -02/24 | 05/20 -05/30 | 07/19 -07/28

External Cargo

HTV6: 6 x Li-Ion Batt + AP [direct mount]

SpX-9: IDA 2

SpX-10: STP-H5, SAGE IP, SAGE NVP

SpX-11: ROSA, MUSES, NICER

SpX-12: CREAM

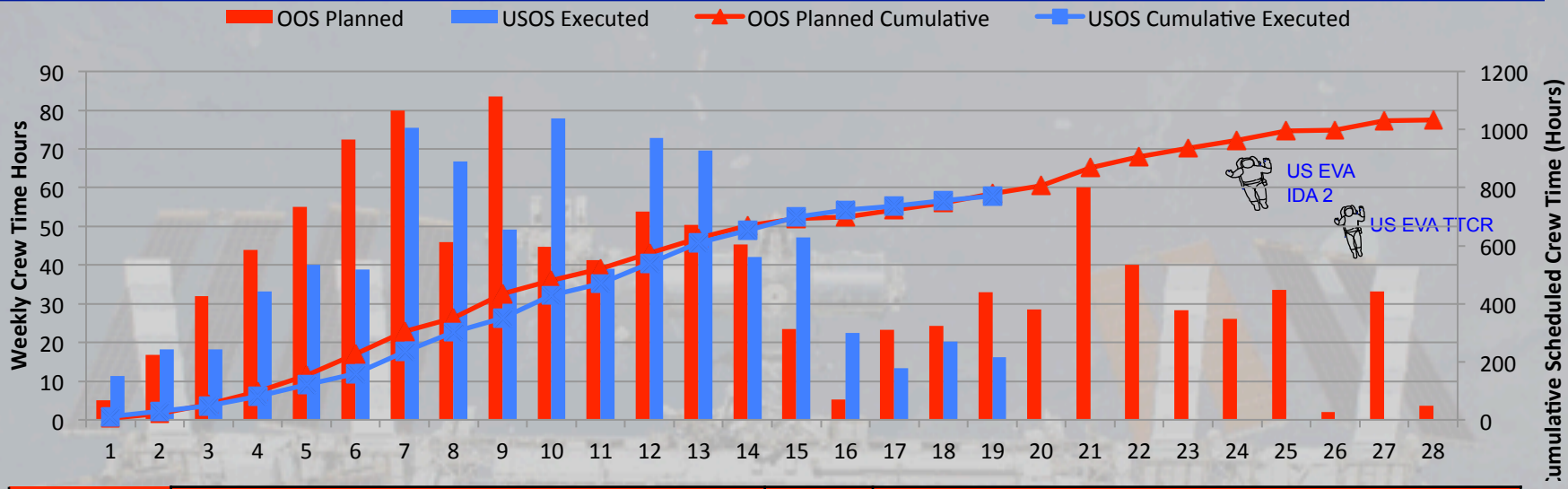
Launch Schedule

SpX-9	OA-5	HTV6	SpX-10	OA-7	SpX-11	SpX-Demo1	SpX-12	OA-8	SpX-Demo2
7/18	NET 8/22	NET 9/30 (10/1 JST)	11/11	12/30	2/1	5/12	6/1	7/6	8/24

N°731 MS | N°433 MS-03 | N°732 MS-02 | N°434 MS-04 | N°733 MS-03 | N°435 MS-05 | N°734 MS-04 | N°735 MS-05 | N°436 MS-06

47S 7/7 | 64P 7/16 (Late GMT) | 48S 9/23 | 65P 10/20 | 49S 11/15 | 66P 2/1 | 50S 3/11 | 51S 5/29 | 67P 6/15

Inc 47 - 48 Utilization Crew Time

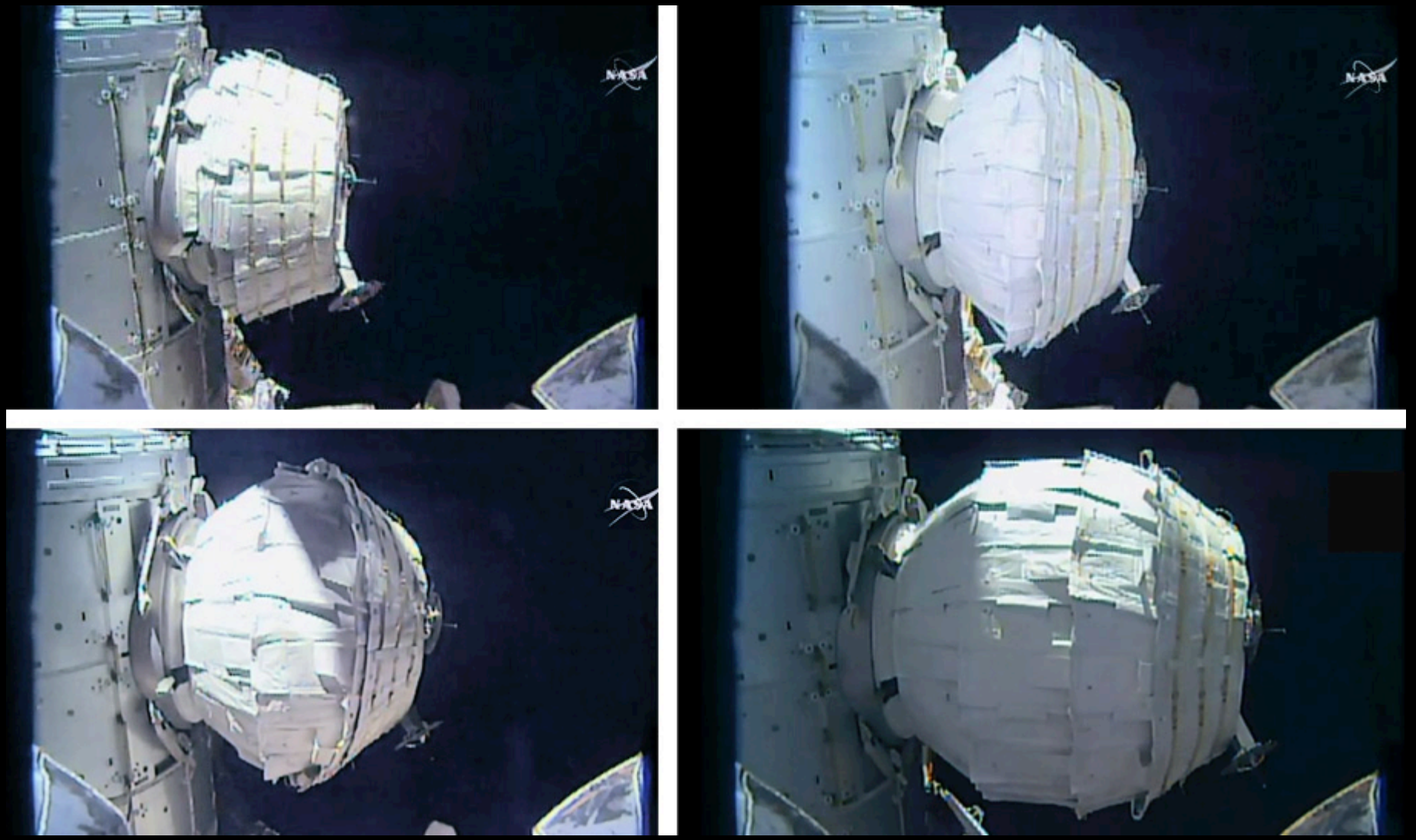


Executed through Increment Wk (WLP Week) 19 =	17.6 of 25.8	work weeks 68.22% through Increment
USOS IDRD Allocation:	1,021.00	hours
OOS USOS Planned Total:	1,034.33	hours
USOS Actuals:	771.67	hours
	75.58%	through IDRD Allocation
	74.61%	through OOS Planned Total
Total USOS Average Per Work Week:	43.84	hours/work week
Voluntary Science Totals to Date:	0	hours (Not included in the above totals or graph)
RSA/NASA Joint Utilization to Date:	32.5	Hours (not included in the above totals or graph)

Wk15 data under review

Color Key:
Completed
Final OOS
FPIP Plan

BEAM Expanded on Space Station – May 28, 2016



Astronauts Enter BEAM – June 6, 2016

Increments 47 & 48 Research Plan - Investigation List

Human Research

Bone & Muscle Physiology
Bisphosphonates (Control), Sprint, Marrow, Tbone (P), Brain-DTI (P), CARTILAGE (P), EDOS-2, Muscle Biopsy (P)

Cardiovascular & Respiratory Systems
Cardio Ox, Vascular Echo, Airway Monitoring, IPVI

Crew Healthcare Systems
Skin-B

Habitability & Human Factors
Body Measures, Fine Motor Skills, Habitability

Human Behavior & Performance
Cognition, At Home in Space, Circadian Rhythms, Synergy (P)

Human Microbiome
Microbiome

Immune System
Salivary Markers, IMMUNO-2, Multi-Omics

Integrated Physiology & Nutrition
Biochem Profile, Telomeres (P), Repository, Dose Tracker, Energy, MARES, Biological Rhythms 48hrs

Nervous & Vestibular Systems
NeuroMapping, Field Test (P), Space Headaches, Straight Ahead in Microgravity (P)

Vision
Fluid Shifts, Ocular Health

Biology and Biotechnology

Animal Biology
Rodent Research-3
Space Pup, Mouse Epigenetics-1

Cellular Biology
Micro 9, Micro 10, NanoRacks Mod-28, Heart Cells*, WetLab-2, Stem Cells, Cell Mechanosensing-3, Spheroids, Payload Card-X

Macromolecular Crystal Growth
CASIS PCG 4, JAXA PCG Demo 2, JAXA PCG

Microbiology
Microbe-IV, Myco, BRIC-NP*, BRIC -23*, Microbial Observatory-1

Plant Biology
Auxin Transport
Plant RNA Regulation*, Veg-03, NanoRacks Mod -33 (Agar), Plant Gravi Sensing-3

Physical Sciences

Combustion Science
Cool Flame Investigation (CFI), FLEX 2*

Complex Fluids
OASIS*, ACE H2*, ACE T-1 ACE T-9*

Fluid Physics
Marangoni-UVP, Two-Phase Flow, PBRE*
Hard to Wet Surfaces*
Microchannel Diffusion

Fundamental Physics
DOSIS-3D, MagVector*

Materials Science
EML Batch – 1 , MSL 2b, SODI DC Mix-III*,Manufacturing Device, Synthetic Muscle*, NanoRacks Module -40*, ELF Batch #3,4

Earth & Space Science

Astrobiology/Astrophysics/Heliophysics
AMS-02 (E), Meteor, NanoRacks Mod-24*, Solar-SOLACES/SOLSPEC (E), CALET (E)[4], MAXI(E)

Earth Remote Sensing
CATS (E), HICO-RAIDS (HREP) (E), ISS-RapidScat (E), NREP Inserts

Near-Earth Space Environment
SEDA-AP (E), Ex-HAM #1 (E), #2 (E)

Technology Development and Demonstration

Characterizing Experiment Hardware
ESA-Haptics-1,-2*, ARTE (ASI), Biomolecular Sequencer, NanoRacks Mod-29*, MVIS Microcontroller -1 , NanoRacks Black Box

Communications & Navigation
MobiPV*, METERON , Vessel ID System, Maritime Awareness*, Scan Testbed

Fire Suppression and Detection
Saffire I/II

Multipurpose
Programmable Isolation Mount*

Repair and Fabrication
3D-Printer*

Power and Thermal Management Systems
Phase Change HX, Universal Battery Charger.

Radiation Measurements & Shielding
Area PADLES, PS-TEPC, Radi-N2, REM

Avionics & Software
SNFM, Telescience Resource Kit*
NanoRacks Module -63*

Life Support and Habitation
Mini Exercise Device-2, UBNT

Air, Water and Surface Sampling
Water Monitoring Suite, Personal CO2 Monitor*

Robotics & Imaging
HDEV (E), Gecko Gripper*, Robonaut, RRM Phase 2 (E), JAXA HDTV

Spacecraft and Orbital Environments
Long Duration Sorbent Test bed, Strata-1, REALM, SPHERES Tether*, SPHERES Halo*

Space Structures and Materials
BEAM, Manufacturing Device, REBR-W

Small Satellites & Control Technologies
NanoRacks NRCSD ext*, JSSODM-1, JSSOD#5, EFU Adapter RTcMISS, SPHERES UDP*, SPHERES Slosh*

Educational Activities

Educational Competitions
SPHERES-Zero-Robotics

Educational Demos
ESA-EPO-PEAKE, ISS Ham Radio, Story Time Demo*, Tomatosphere*, JAXA EPO
Sally Ride EarthKAM

Student-Developed Investigations
NR Modules-16, -18, -20, -21, -22, -51
NanoRacks Module-9, Mod-48*, Genes in Space*, NanoRacks Modules* -41, -43, -44, -45, -46,-69

Classroom Versions of ISS Investigations
Windows on Earth

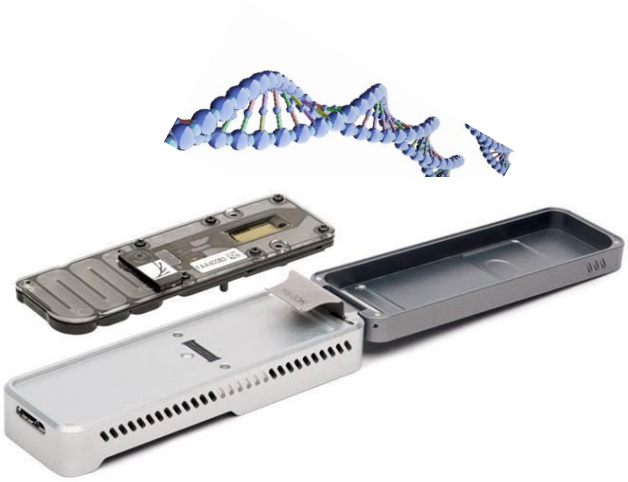
NASA NatLab CSA ESA JAXA

Ascent/Descent, **(P)** Pre/Post only, * Added by CEF, **(E)** External Payload

Featured Investigations:
Technology Development and Demonstration

Biomolecule Sequencer

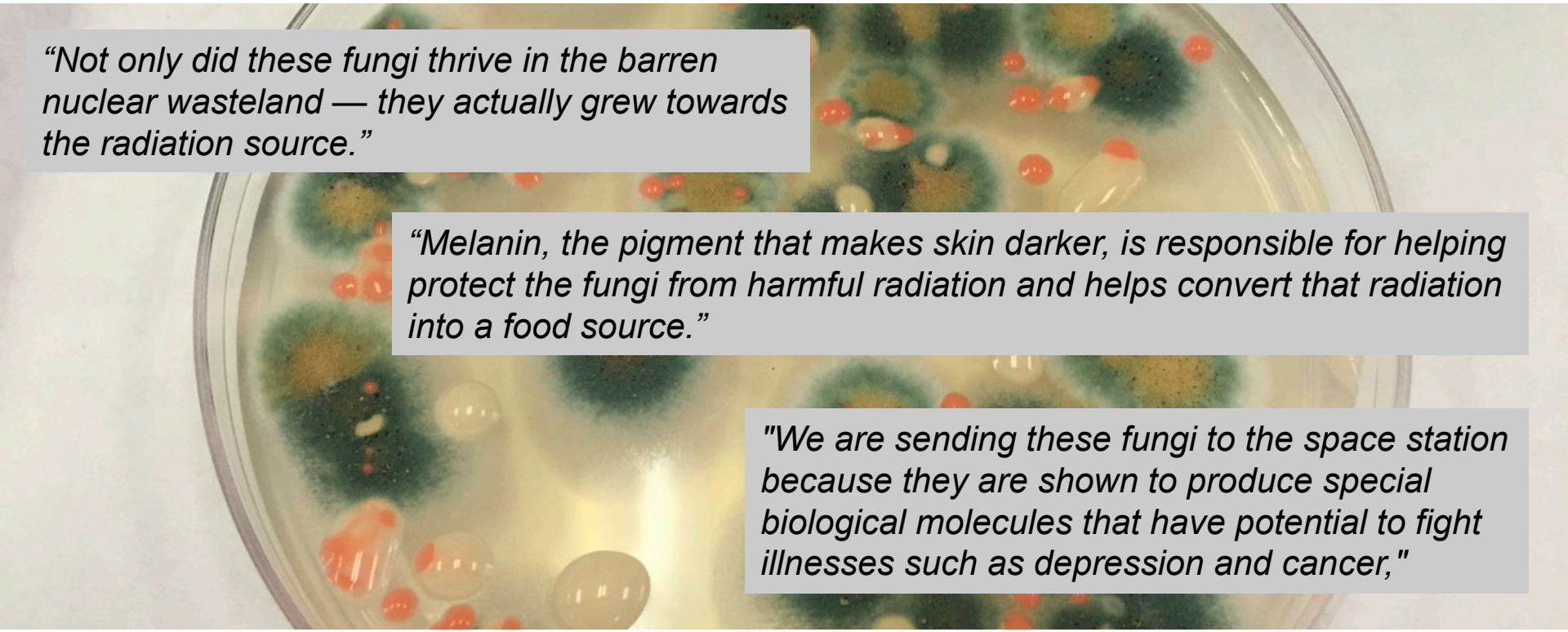
- The Biomolecule Sequencer investigation seeks to demonstrate, for the first time, that DNA sequencing is feasible in an orbiting spacecraft. A space-based DNA sequencer could identify microbes, diagnose diseases and understand crew member health, and potentially help detect DNA-based life elsewhere in the solar system.



Phase Change HX

•The Phase Change Heat Exchanger Project seeks to advance the technology readiness level of phase change heat exchangers for infusion into future exploration vehicles. Phase change material heat exchangers are a useful technology that serve as a supplemental heat rejection device during time-varying heat loads and/or transient environments by storing waste energy by melting a phase change material during peak loads. It can then reject this energy through a radiator when conditions allow, causing the phase change material to freeze.

Molecules Produced in Microgravity from the Chernobyl Nuclear Accident



“Not only did these fungi thrive in the barren nuclear wasteland — they actually grew towards the radiation source.”

“Melanin, the pigment that makes skin darker, is responsible for helping protect the fungi from harmful radiation and helps convert that radiation into a food source.”

"We are sending these fungi to the space station because they are shown to produce special biological molecules that have potential to fight illnesses such as depression and cancer,"

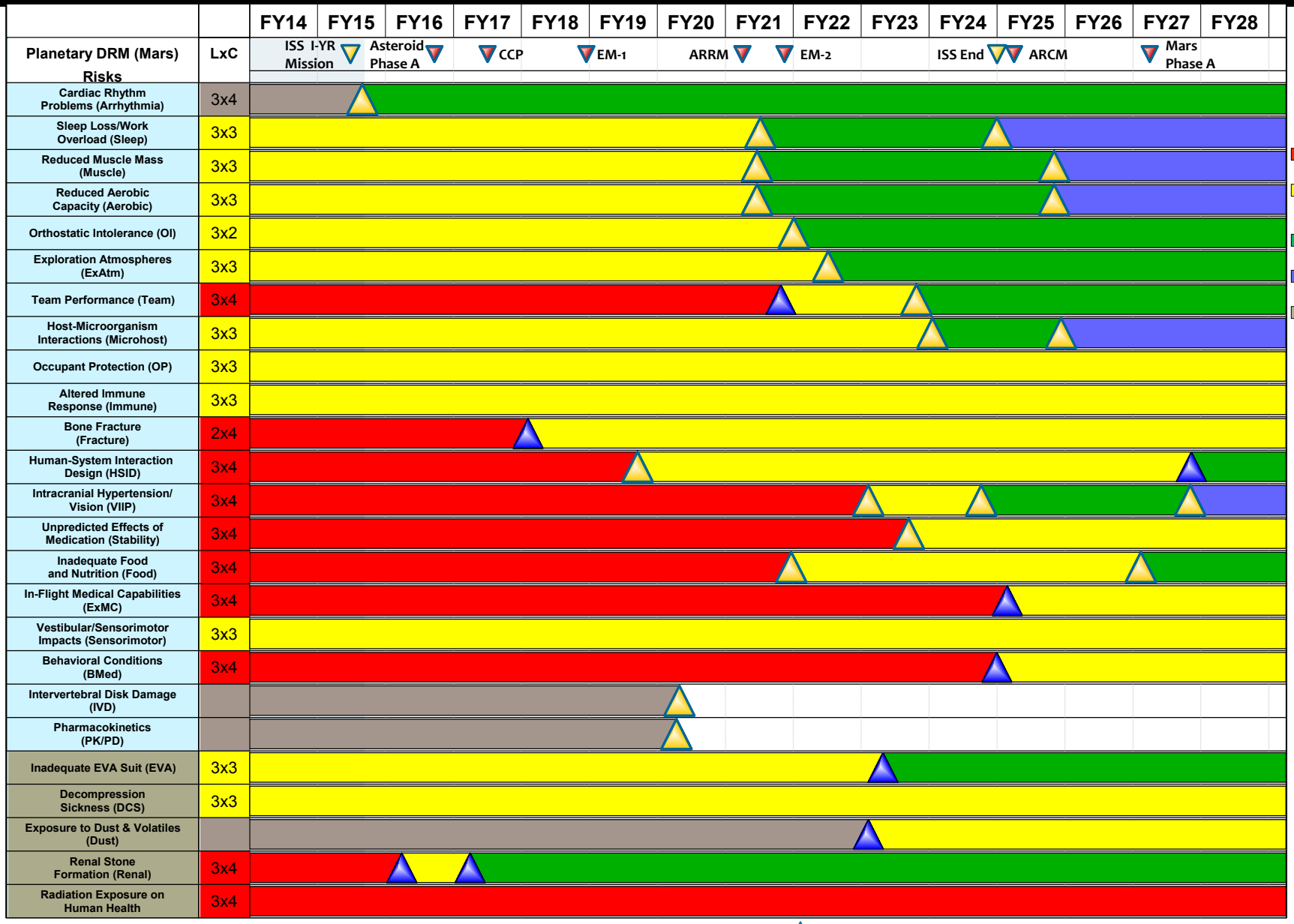
Principal Investigator: Dr. Kasthuri Venkateswaran

Affiliation: Jet Propulsion Laboratory/Caltech

Partnership between JPL, Berkley Labs and CASIS

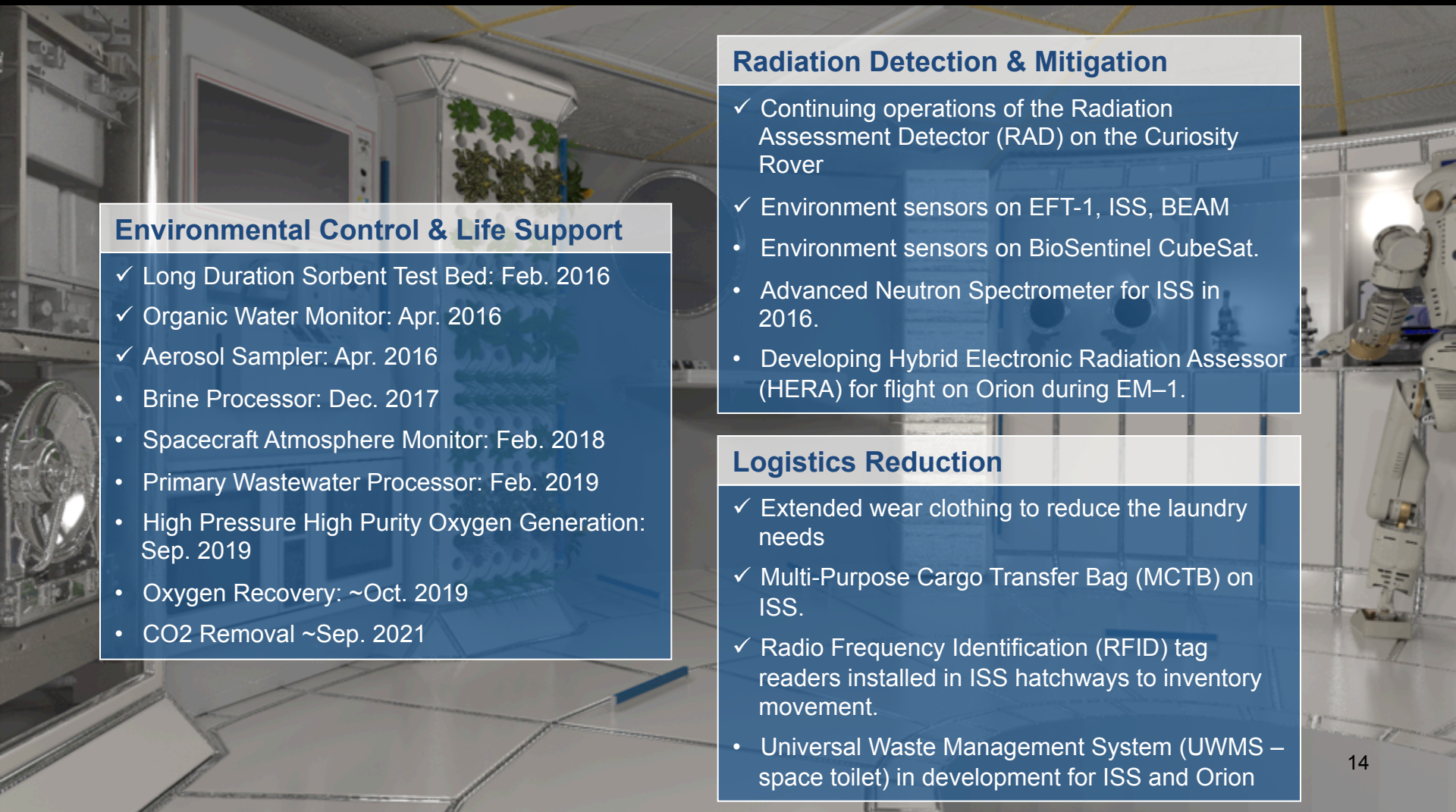
Fungal strains isolated from the Chernobyl nuclear power plant accident will be screened for the secretion of natural products that could be beneficial for biomedical and agricultural applications. Since fungal strains isolated in and around the ChNPP produce agro- and pharma-related natural products on Earth, the NPμG team proposes to test the fungal cells under stressful microgravity conditions to measure whether they can produce novel secondary metabolites.

Integrated Path to Risk Reduction, Revision C (2015)



Habitation Systems
Testing on Space Station & Beyond

An integrated array of complex systems and components that include environmental control and life support systems, docking capability, logistics management, radiation mitigation and monitoring, fire safety technologies, and crew health capabilities.



Environmental Control & Life Support

- ✓ Long Duration Sorbent Test Bed: Feb. 2016
- ✓ Organic Water Monitor: Apr. 2016
- ✓ Aerosol Sampler: Apr. 2016
- • Brine Processor: Dec. 2017
- • Spacecraft Atmosphere Monitor: Feb. 2018
- • Primary Wastewater Processor: Feb. 2019
- • High Pressure High Purity Oxygen Generation: Sep. 2019
- • Oxygen Recovery: ~Oct. 2019
- • CO2 Removal ~Sep. 2021

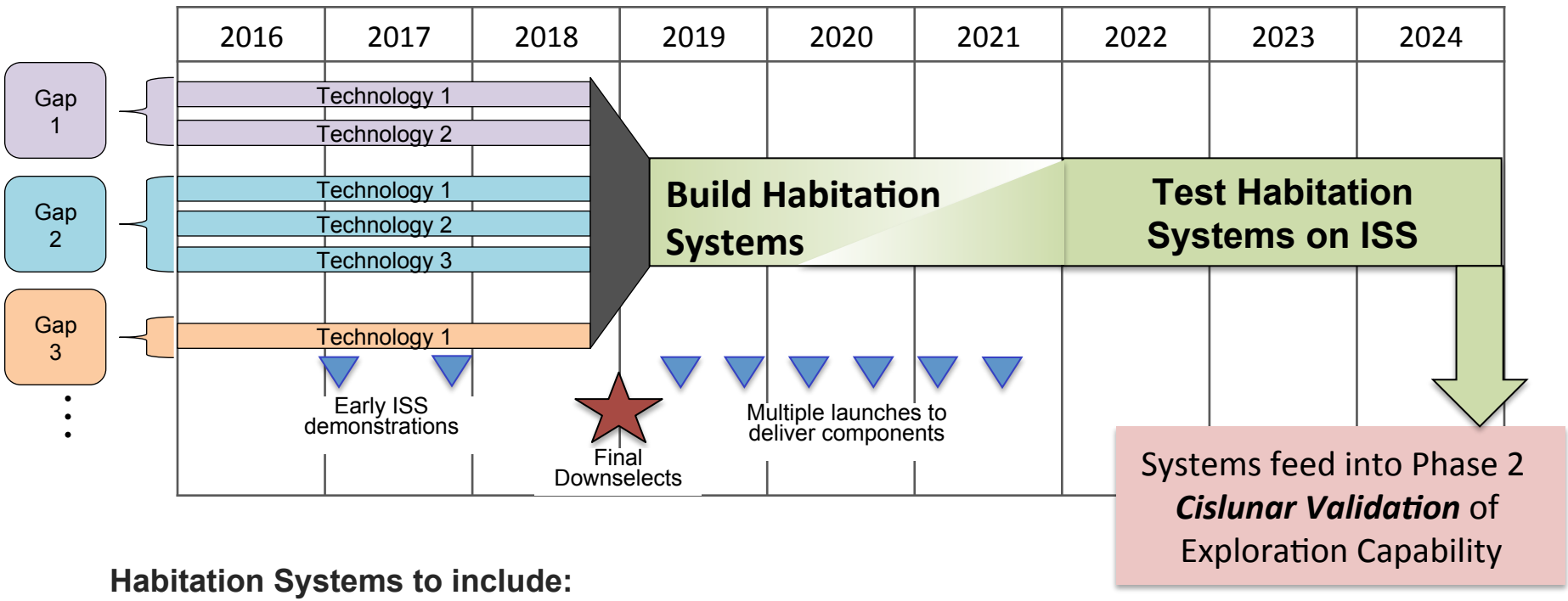
Radiation Detection & Mitigation

- ✓ Continuing operations of the Radiation Assessment Detector (RAD) on the Curiosity Rover
- ✓ Environment sensors on EFT-1, ISS, BEAM
- • Environment sensors on BioSentinel CubeSat.
- • Advanced Neutron Spectrometer for ISS in 2016.
- • Developing Hybrid Electronic Radiation Assessor (HERA) for flight on Orion during EM–1.

Logistics Reduction

- ✓ Extended wear clothing to reduce the laundry needs
- ✓ Multi-Purpose Cargo Transfer Bag (MCTB) on ISS.
- ✓ Radio Frequency Identification (RFID) tag readers installed in ISS hatchways to inventory movement.
- • Universal Waste Management System (UWMS – space toilet) in development for ISS and Orion

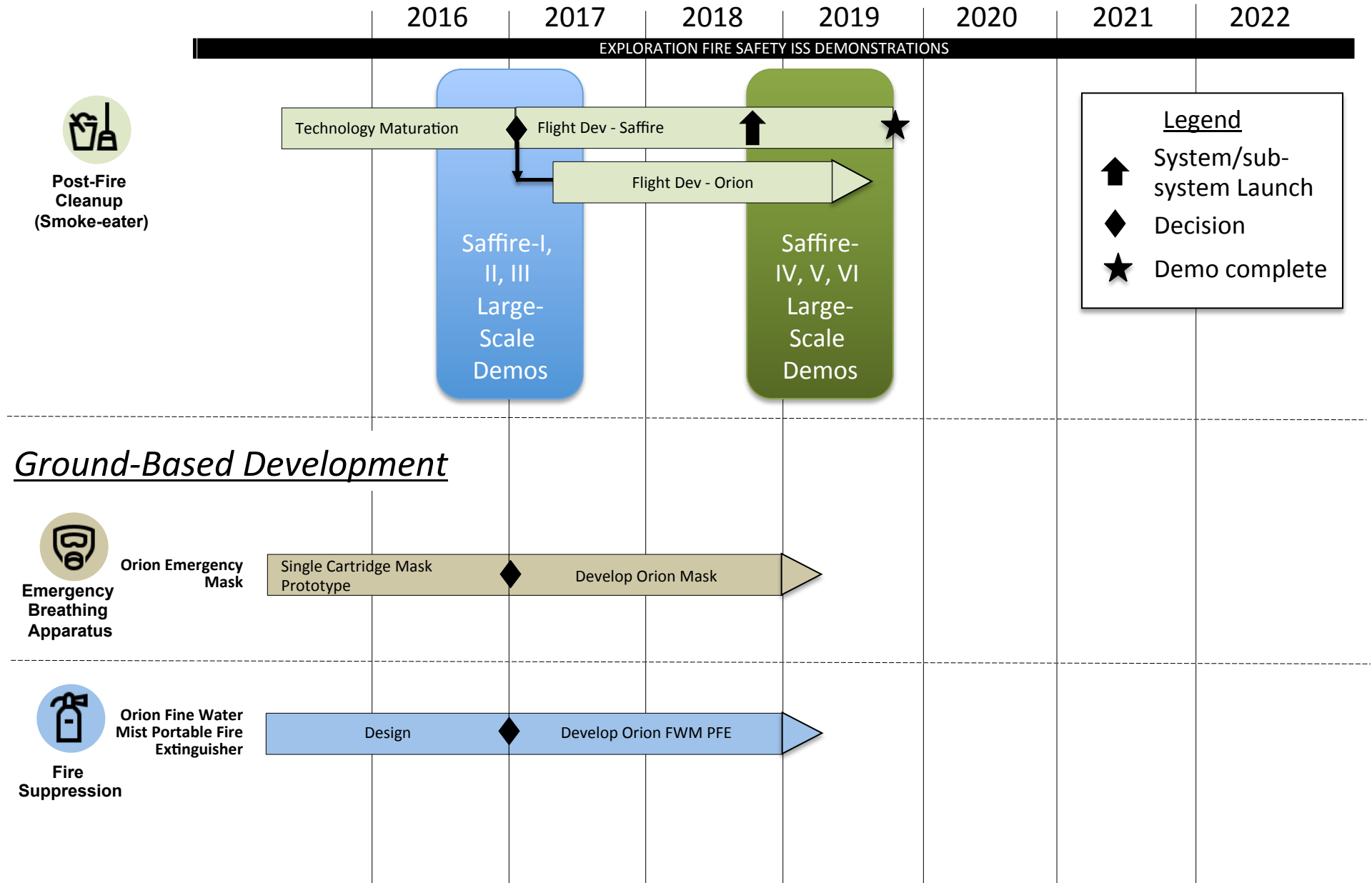
Phase 0 – Habitation Systems Testing on ISS



Habitation Systems to include:

- 4-rack Exploration ECLSS and Environmental Monitoring hardware
- Fire Safety studies and end-to-end detection/suppression/cleanup testing in Saffire series (Cygnus)
- Mars-class exercise equipment
- On-board medical devices for long duration missions
- Long-duration food storage
- Radiation monitoring and shielding
- Autonomous crew operations

Exploration Fire Safety Roadmap



Progress

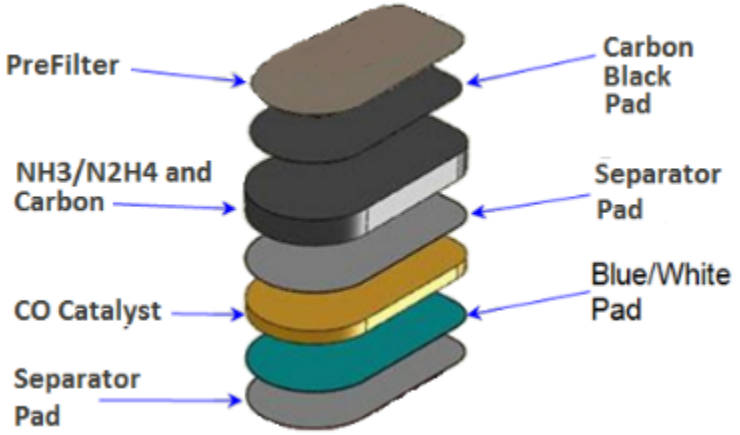
Emergency Crew Mask

- Joint NESC/Commercialization Readiness Program (CRP)-funding to develop a single, rigidly mounted cartridge for emergency response
  - Protect against either a small-scale fire or 30,000 ppmv (3%) ammonia for >15 min
  - TDA, Inc. funded on Phase III SBIR to develop sorbents

Cartridge is 8 cm wide; sorbent bed is 3 cm deep.

Post-fire/leak clean-up (Smoke-eater)

- Smoke-eater system is being developed concurrently with the emergency crew mask
  - Contains the same adsorber stack but is larger than the crew mask
- Self-contained unit includes a fan
- Demo in Saffire-IV-VI will only include CO catalyst and sized for the Cygnus vehicle and anticipated fire in Saffire



Progress

Fire Suppression

- Determined amount of water to extinguish WSTF battery fire
- Developing light-weight extinguisher tanks based on ISS fine water mist (FWM) portable fire extinguisher (PFE) technology
  - Welded titanium with in internal rubber bladder
  - Carbon-over-wrapped pressure vessel
- Will evaluate performance of prototype systems

Engineering Development Unit of an ISS FWM PFE

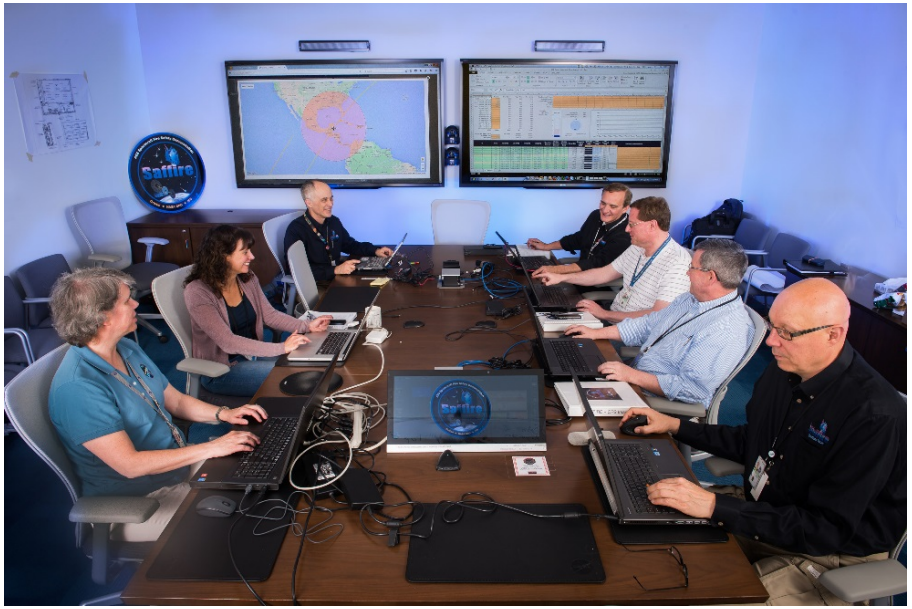
Discharge against the stored energy battery fire (left) and prior to discharge against an open cabin fire (right).

Saffire-I Operations: *June 14-20, 2016*

NASA and Orbital ATK teams at MCC-Dulles (above) and Flight Operations-GRC (right) conducted and monitored Saffire-I operations

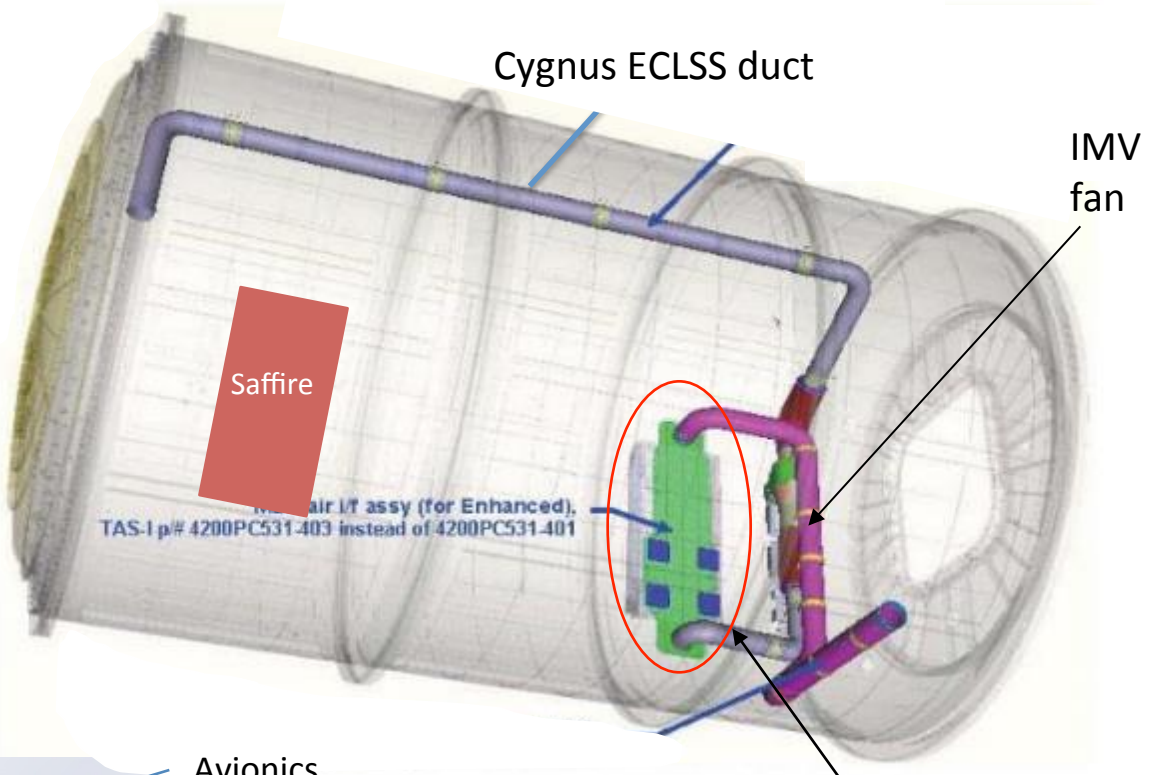
- **Operations received considerable coverage on social media**
  - NASA GRC and Advanced Exploration Systems Division (AES)

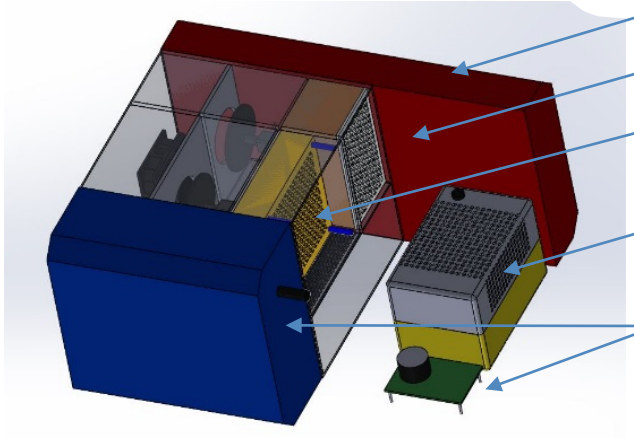
- **OA-6 unberthed from the ISS at 9:30 a.m. EDT on June 22**
- **Saffire-I was powered on at 2:23 p.m.**
- **RUN command was sent at 4:41 p.m.**
  - Ignition at 4:44 p.m.
- **Cygnus smoke detector readings received at 4:52 p.m.**



Saffire IV - VI Hardware Concept

- Concept consists of three distinct hardware locations
  - Saffire flow unit
  - Far-field diagnostic
  - Distributed sensors
- Far-field diagnostic module
  - Combustion product monitor
  - CO and CO_2 sensors
  - Post-fire cleanup module
- Distributed sensor network
  - Temperature
  - CO_2

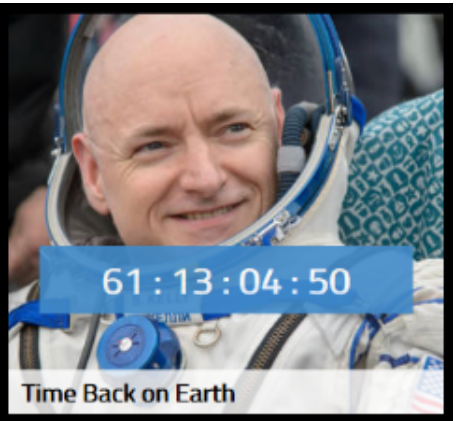




Far-field diagnostics module

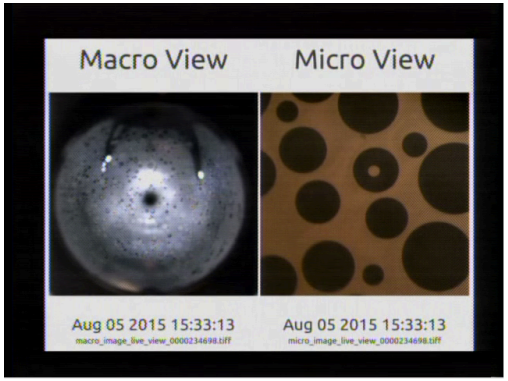
2016 Science Highlights

One Year Mission



2016 Science Highlights

Observation and Analysis of Smectic Islands in Space (OASIS)



Pore emulsions

Emulsions form compact aggregates

OASIS observes the various aspects of liquid crystals behavior in microgravity such as overall fluid motion, diffusion (the movement of particles from an area of high concentration to low concentration) and the merging of liquid crystal film layers called islands. 2016 research found novel, unpredicted behavior of liquid crystals.

PI: Noel Clark, University of Colorado (NAS, APS Buckley Prize in Condensed Matter Physics)
Co-Investigators: Joseph Maclennan, Ph.D., University of Colorado, Boulder, CO
Matt Glaser, Ph.D., University of Colorado, Boulder, CO
Ralf Stannarius, Ph.D., Magdeburg University, D39106 Magdeburg, Germany
Alexandr Levchenko, Ph.D., Russian Academy of Sciences, Moscow, Russia
Vladimir Dolganov, Ph.D., Russian Academy of Sciences, Moscow, Russia
Pavel Dolganov, Ph.D., Russian Academy of Sciences, Moscow, Russia
Efim Kats, Ph.D., Russian Academy of Sciences, Moscow, Russia

Orion Accomplishments

Five of nine water drop tests at Langley Research Center in Virginia

European Service Module Structural Test Article (ESM STA) completes acoustic testing Glenn Research Center Plum Brook Station in Ohio

ESM STA solar panel array deployment test at Glenn Research Center Plum Brook Station in Ohio

Orion avionics mockup at the Lockheed Martin Integrated Test Lab in Littleton, Colorado

EFT1 Crew Module acoustic testing at Lockheed Martin in Littleton, Colorado

Suited hand controller evaluation in the medium fidelity mockup at the Johnson Space Center in Houston, Texas

SLS Accomplishments

Launch Vehicle Stage Adapter STA Complete

Engine 2059 removed from stand

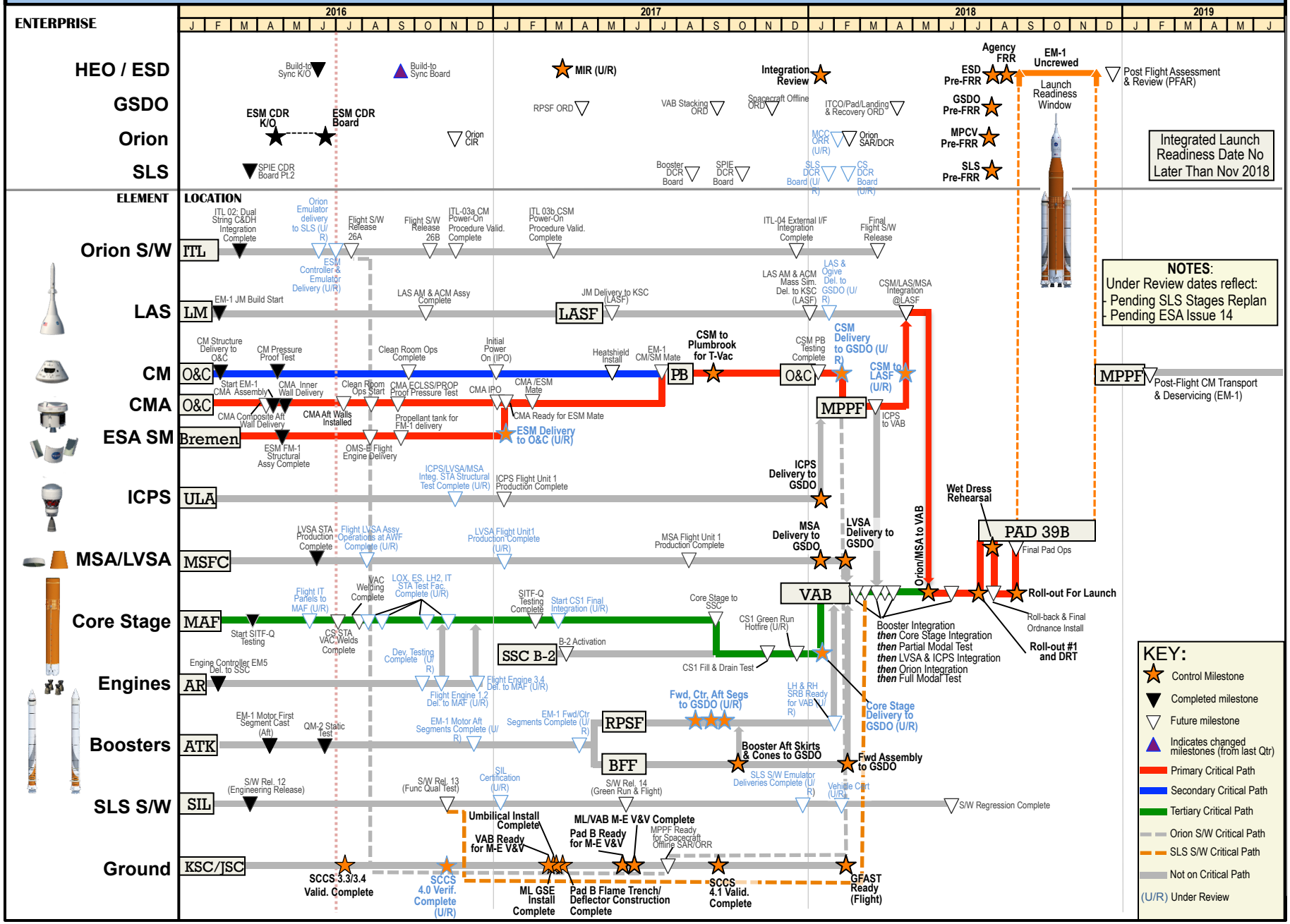
Interim Cryogenic Propulsion Stage STA delivered to Marshall

Qualification Motor-2 Booster chill-down for June 28, 2016 test

Liquid Oxygen Tank STA completed vertical welds

ESD EM-1 INTEGRATED MISSION MILESTONE SUMMARY

NASA ESD
Chart Updated: 6 July 2016, Rev A



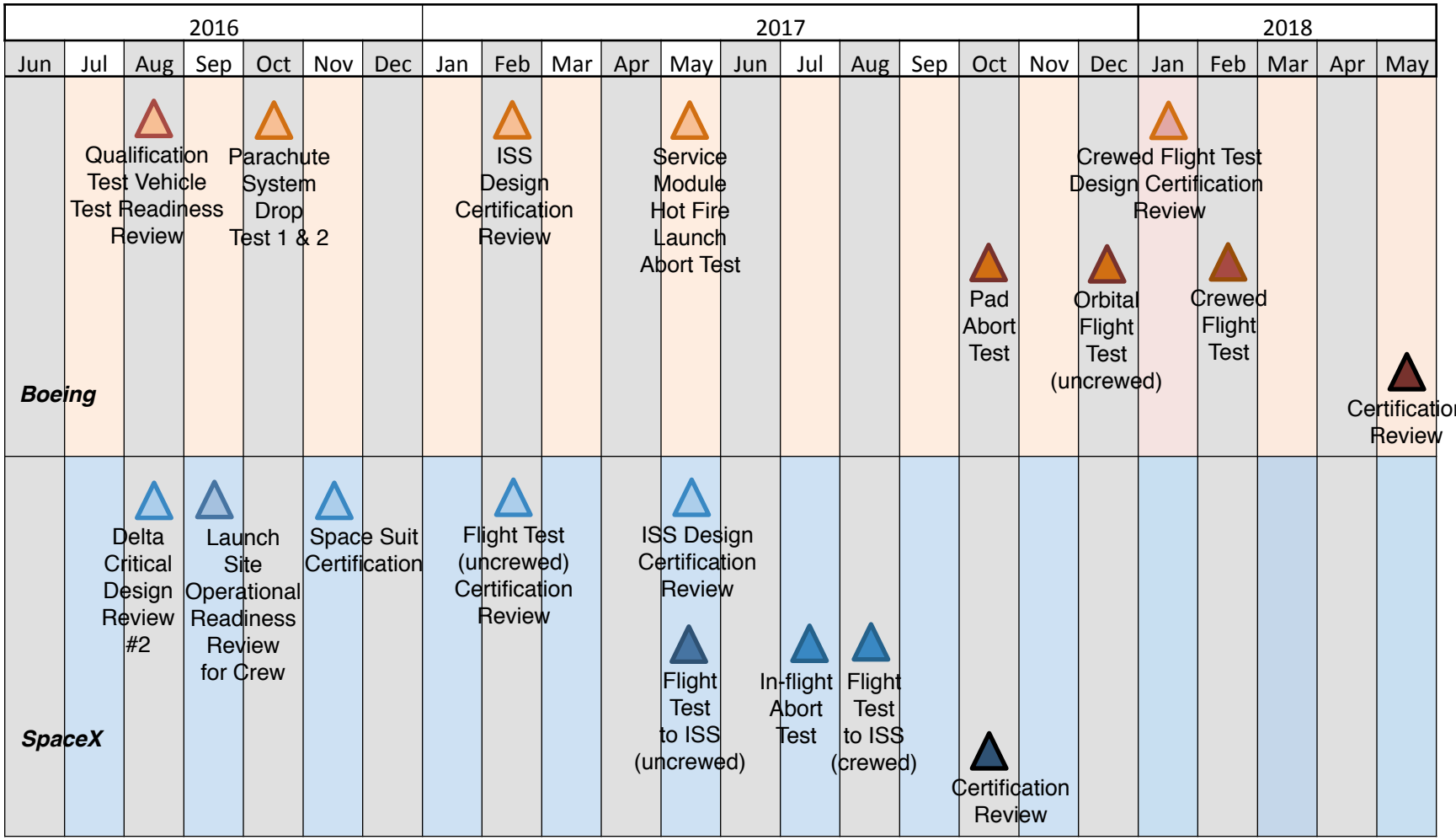
For comments contact mark.e.ogles@nasa.gov

CCP Accomplishments

CCP has made significant progress over the last quarter, notably:

- **Boeing and SpaceX are advancing their design concepts**
  - Actively building and testing hardware to inform design
  - Engaging in meaningful insight with NASA
  - Addressing important design challenges
- **CCP continues to burn down key products with the partners**
  - Over 90% of the alternate standards are completed
  - Over 60% of the variances are completed
  - Over 60% of the Phase 2 hazard reports are completed
- **Eight CCP missions now in process (two test flights per partner and two Post Certification Missions per partner)**
- **Extended the Sierra Nevada Corporation Space Act Agreement to the Summer of 2017 to enable an Approach and Landing flight test.**
- **Entered into a new, unfunded Space Act Agreement with Blue Origin for orbital human space transportation system development**

CCP Major Partner Milestones



ARM Progress

Capture Module Prototyping/Testing
at Goddard Space Flight Center

Robot Subsystem - Microspine Gripper
Jet Propulsion Laboratory

HEOC Finding on Current NASA Status

- **Finding:** The HEOC commends the NASA Advisory Council and outgoing Chairman Dr. Stephen Squires for their commitment, leadership, and pertinent recommendations over the last several years. The deliberations of the NAC will continue to be essential for NASA as changes will likely follow the national elections in November 2016.
- The HEOC supports the current systematic approach to the ultimate goal of human exploration of Mars that is guided by the three domains of NASA's "Journey to Mars" strategy, which builds sequentially from Earth dependent to proving ground to Earth independent.
- We commend the leadership and staff of NASA HQ and the Centers for the steady progress being made on ISS, Commercial Crew, Orion, and SLS.

HEOC Finding Concerning Soyuz Transportation

- **Finding:** HEOC is concerned about the possibility of a gap in ISS transportation for NASA crew. The current schedules of both Commercial Crew Program (CCP) providers show completion of certification in time to allow for crew rotation to ISS in CY2018, however there is very little margin. Human spaceflight development programs invariably suffer schedule slips due to their technical complexity; the integration of commercial providers into government service adds further obstacles to CCP.
- It is therefore prudent to assume delays in post-certification missions from today's schedule. Since NASA has purchased Soyuz seats only through CY2018, any delay of CCP operational capability beyond CY2018 will result in the inability to send NASA astronauts to ISS until one of the CCP providers can complete certification.
- Due to long lead time required to procure Soyuz seats, a decision must be made by the end of CY2016 to guarantee access to ISS in CY2019, or NASA may be forced to reduce – or possibly eliminate – its crew complement aboard ISS.

HEOC Finding on Technology Development and Mars Architecture

- **FINDING:** The overall architecture for "Journey to Mars" has matured to the point that allows effective focus on the next steps to successfully meet the goal of humans exploring Mars. A sound detailed architecture through the next ten years is needed to allow adequate definition of technology development requirements.

- To ensure time and money are effectively utilized toward the "Journey to Mars" campaign:
  - Continue to review, identify, and refine the technology needs. Then the schedule and cost should be developed for implementation in a timely manner.
  - Develop schedules and implementation of elements for Phases 1&2 of the campaign to ensure NASA R&D is positioned to efficiently accomplish Phases 3&4.

Observations from HEOMD Presentations

- HEOMD has added detail to plans for human exploration missions in the 2020's to identify near term technology development requirements.

- ISS test bed for technology development for deep space exploration is critical and good definition has been made on identifying priorities and critical work to be accomplished during ISS operational lifetime.

- Continued progress is being made on Commercial Crew, SLS, and Orion with no major schedule adjustments due to technical or resource issues.

- ARM planning and development is continuing. The Formulation and Assessment Team's report has been very helpful. Engagement with the Small Body Assessment Group has improved science potential. Planetary defense objectives have been included.

Top Concerns

•Bureaucratic processes that NASA imposes on itself do not always add value to balance their load on the organization and are a threat to accomplishment of NASA's exploration mission.

•The number and intensity of current reviews of the HEO programs are not helpful and use too many precious resources. The IG and GAO should coordinate and prioritize their reviews.

•Low SLS and Orion Launch rate pose future risks for proficiency of the operations team and reduce program resilience in the event of mission failure

•Budget uncertainty and reduced flexibility in funding accounts make it more difficult than ever for program managers to meet technical and schedule objectives.

Special Topics at Future HEO Committee Meetings

- Briefing from the Human Research Program on progress and remaining challenges
- International Participation in Future Human Exploration
- Plans for Transition of Administration
- ISS Research
- ISS Component Reliability
- Lunar Distant Retrograde Orbit
- Briefings from Selected System Maturation Team Leads
- Integrated Testing Program/Schedule for “Journey to Mars”

HEOC Items for Continued Review

- NASA Management Processes
- Certification of readiness process for commercial crew
- ISS Uses for Exploration Development, Transition, and Exploration Plans Beyond ISS
- Commercial Involvement in Future Human Exploration